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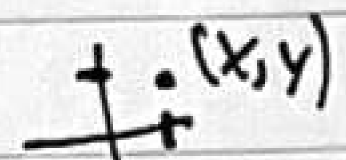
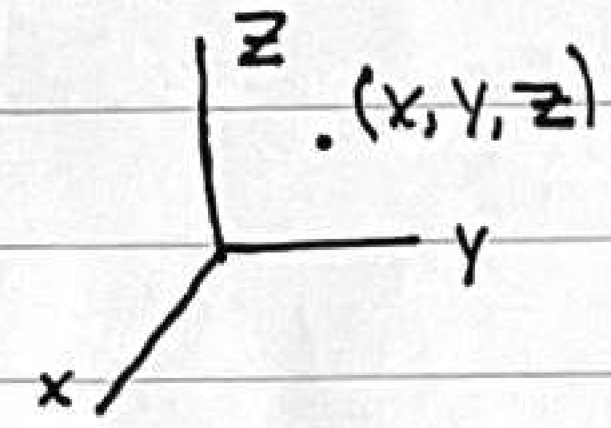
12.1 - Coordinates in 3-space ($\mathbb{R}^3$)

($\mathbb{R}^2$) 2-space: 

$\mathbb{R}^2 = \{(x,y) : x, y \in \mathbb{R}\}$

($\mathbb{R}^3$) 3-space: 

$\mathbb{R}^3 = \{(x,y,z) : x, y, z \in \mathbb{R}\}$

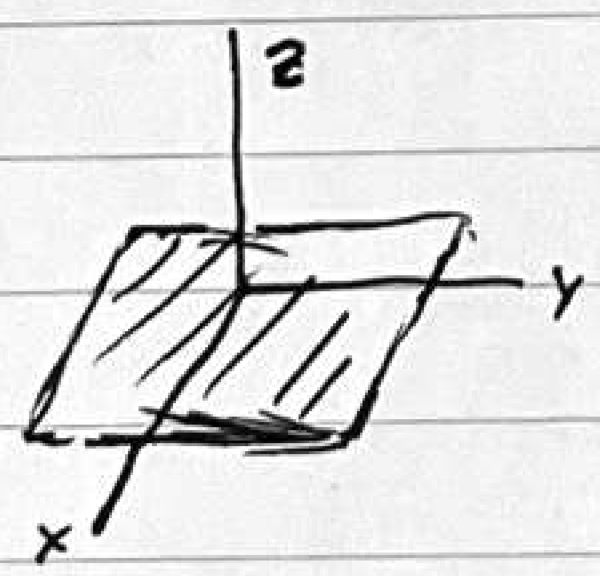
Th coordinates of a point (x,y,z) are x, y, z...

I. Coordinate planes

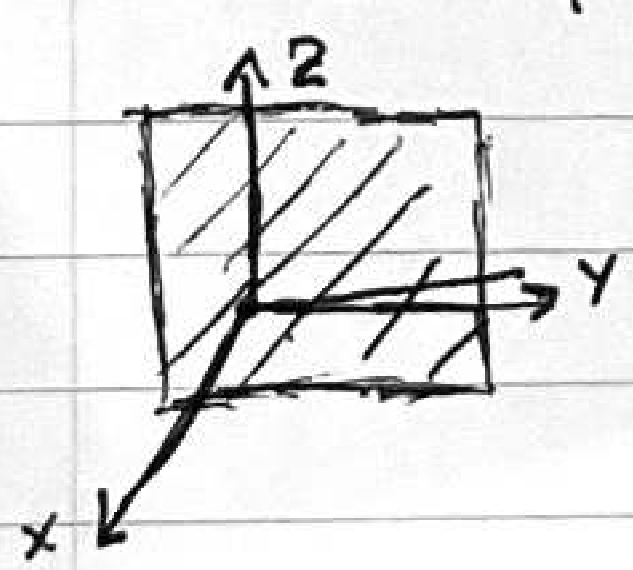
A coordinate plane in $\mathbb{R}^3$ is a set of points, all of which have a (predetermined) coordinate set to 0.

ex/

Th xy plane in $\mathbb{R}^3$ is th $z=0$ plane, i.e. $\{(x,y,z) \in \mathbb{R}^3 : z = 0\}$

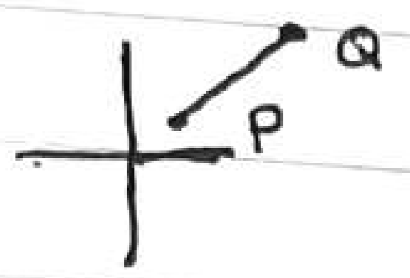


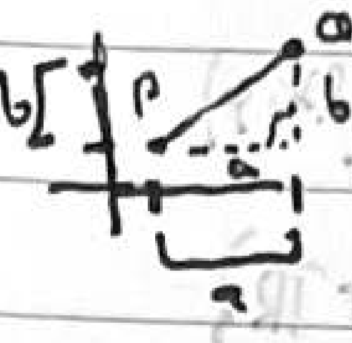
Th yz plane in $\mathbb{R}^3$ is th $x=0$ plane, i.e. $\{(x,y,z) \in \mathbb{R}^3 : x = 0\}$



Distances in 3-space

2 space

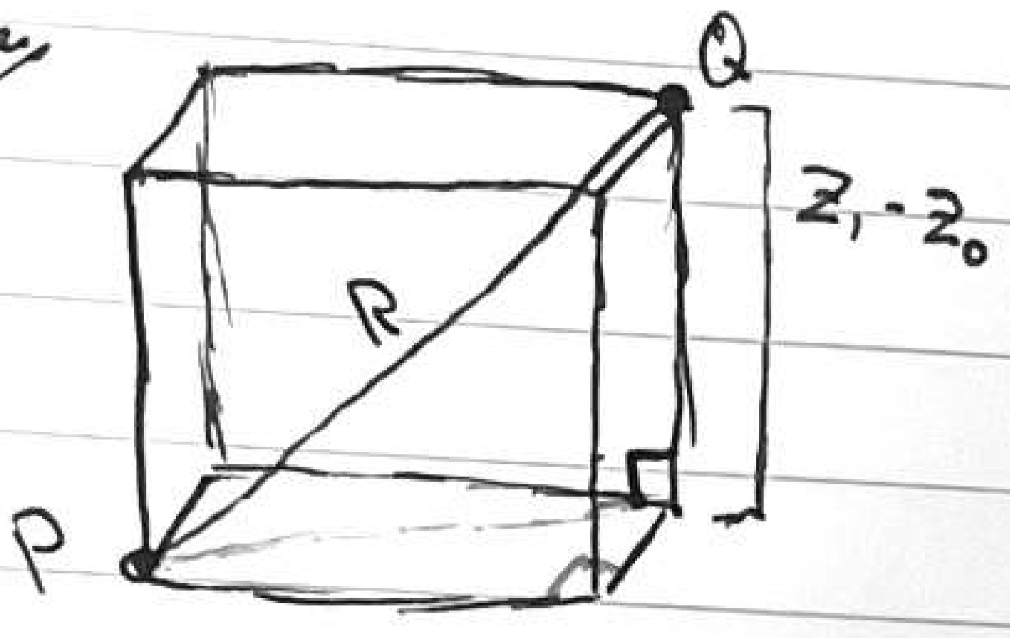
$\mathbb{R}^2$: 

$d(P,Q) =$ 

$$d(P,Q) = \sqrt{a^2+b^2} = \sqrt{(x_Q - x_P)^2 + (y_Q - y_P)^2}$$

$$d(P,Q) = \sqrt{(x_Q - x_P)^2 + (y_Q - y_P)^2}$$

3 space



$$R = \sqrt{(z_1 - z_0)^2 - \left(\sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2}\right)^2}$$

$$R = \sqrt{(z_1 - z_0)^2 + (x_1 - x_0)^2 + (y_1 - y_0)^2}$$

Thm: Let $P = (x_0, y_0, z_0)$ and $Q = (x_1, y_1, z_1)$ be points in $\mathbb{R}^3$.
The distance between them is

$$\boxed{d(P,Q) = \sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2 + (z_1 - z_0)^2}}$$